

The opinion in support of the decision being entered today was *not* written for publication and is *not* binding precedent of the Board.

Paper No. 22

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte YA-CHIN KING,
TSU-JAE KING
and
CHEN-MING HU

Appeal No. 2001-2590
Application No. 09/449,063

ON BRIEF

Before WARREN, KRATZ and MOORE, *Administrative Patent Judges*.
MOORE, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 from the final rejection of claims 1-8 and 10-15. Claims 9 and 16-20 have been cancelled. Thus, only claims 1-8 and 10-15 are before us on this appeal.

REPRESENTATIVE CLAIMS

The appellants have stated that the claims do not stand or fall together. However, they have presented only single arguments for each ground of rejection. Claims must be argued separately on appeal or they stand or fall together. In re Dance, 160 F.3d

Appeal No. 2001-2590
Application No. 09/449,063

1339, 1340 n.2, 48 USPQ2d 1635, 1636 n.2 (Fed. Cir. 1998).

Consequently, we select claims 1, 7, and 13 (the broadest independent claims) to be representative of the claims on appeal.

They read as follow:

1. A method of forming a multiple-thickness oxide layer on a silicon substrate for use with transistors having different gate oxide thicknesses, the method comprising:

a) forming a sacrificial oxide layer on the silicon substrate;

b) patterning an implant mask layer on the silicon substrate to expose a selected first portion of the silicon substrate;

c) implanting oxygen into the selected first portion of the silicon substrate through the sacrificial oxide layer;

d) stripping the implant mask layer from the silicon substrate;

e) stripping the sacrificial oxide layer; and

f) growing an oxide layer on the silicon substrate, the oxide layer having an oxygen-implanted oxide region for the first transistor gate oxide and a non-implanted oxide region for a second transistor gate oxide.

7. A method of forming a multiple-thickness oxide layer on a silicon substrate for use with transistors having different gate oxide thicknesses, the method comprising:

a) forming a sacrificial oxide layer on the silicon substrate;

b) patterning an implant mask layer on the silicon substrate to expose a selected first portion of the silicon substrate for a first transistor gate oxide;

c) implanting oxygen into the selected first portion of the silicon substrate through the sacrificial oxide layer including

implanting oxygen into a second portion of the silicon substrate under the implant mask layer, the oxygen concentration in the second portion being less than the oxygen concentration in the first portion, and the oxide layer over the first portion being thicker than the oxide layer over the second portion;

d) stripping the implant mask layer from the silicon substrate;

e) stripping the sacrificial oxide layer; and

f) growing an oxide layer on the silicon substrate, the oxide layer being thicker in the oxygen-implanted oxide region in the selected first portion for the first transistor gate oxide.

13. A method of forming a multiple-thickness oxide layer on a silicon substrate, the method comprising:

a) forming a high dielectric contrast dielectric layer on a silicon substrate;

b) forming a polysilicon layer on the dielectric layer;

c) patterning an implant mask layer on the polysilicon layer;

d) implanting oxygen through the polysilicon layer and into the substrate;

e) stripping the implant mask layer from the substrate; and

f) annealing the substrate to form an interfacial oxide layer in the substrate under the dielectric layer.

The References

In rejecting the claims under 35 U.S.C. §103(a), the examiner relies upon the following references:

Hsu et al. (Hsu)	5,480,828	Jan. 02, 1996
Barsan et al. (Barsan)	5,672,521	Sep. 30, 1997

Appeal No. 2001-2590
Application No. 09/449,063

Wristers et al. (Wristers)	5,930,620	Jul. 27, 1999
Mogami (filed May 18, 1998)	6,027,977	Feb. 22, 2000

The Rejections

Claims 1-6 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Hsu in view of Wristers.

Claims 7-8 and 10-12 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Hsu in view of Wristers as applied to claims 1-6, and further in view of Barsan.

Claims 13-15 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Hsu in view of Mogami.

The Invention

The invention relates to a method for forming gate oxides for transistor devices on a single semiconductor chip with the gate oxides varying in thickness for different transistors. The method steps are outlined in the reproduced claims above.

The Rejection of Claims 1, 3 and 5 Under 35 U.S.C. §103(a)

The examiner has found that Hsu teaches the invention substantially as claimed with the exception of the oxidation effecting material being implanted containing oxygen ions. (Examiner's Answer, page 3, line 17 - page 4, line 5). The examiner has additionally found that Wristers discloses the formation of gate oxides of different thicknesses and shows forming

Appeal No. 2001-2590
Application No. 09/449,063

an oxide layer thicker in one region as opposed to another by using oxygen ions. (Examiner's Answer, page 4, lines 6-8).

The examiner then concludes that it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the nitrogen ions in Hsu with the oxygen ions of Wristers because it would allow Hsu to produce the desired goal of forming gate oxides with different thicknesses in a single processing step. (Examiner's Answer, page 4, lines 8-12).

The appellants note that Hsu uses nitrogen to depress the oxidation rate, and fluorine to increase the oxidation rate of a silicon layer, but not oxygen. Wristers, it is urged, is concerned only with the provision of a gate dielectric layer of uniform thickness within an isolation structure with the oxide thickness in the isolation structure being thicker to reduce the electric field across the guard ring. Consequently, it is reasoned, that Wristers is not concerned with providing gate oxide layers of different thicknesses for different transistors in a semiconductor chip. (Appeal Brief, page 6, lines 5-20).

We note that it is not in dispute that Hsu is almost identical to the instantly claimed invention. The only discernable difference between the claimed subject matter and Hsu is the passage at column 2, lines 44-50 which states:

Appeal No. 2001-2590
Application No. 09/449,063

Nitrogen ions 14 are implanted through the sacrificial silicon oxide layer 12 into the semiconductor substrate 10 in the planned 3 V transistor region not covered by the photoresist. The ions are implanted at a dosage of between about $1 \text{ E } 14$ to $3 \text{ E } 14$ atoms/cm² and energy of between about 30 to 50 KeV. The nitrogen ions within the semiconductor substrate will depress the oxidation rate of the substrate.

In other words, Hsu teaches that a nitrogen implanted area will grow an oxide layer more slowly, resulting in a thinner gate oxide layer. Hsu also teaches an alternative means for increasing the oxidation rate using fluorine in a so-called second preferred embodiment discussed at column 3, lines 11-20:

Fluoride ions 15 are implanted through the sacrificial silicon oxide layer 12 into the semiconductor substrate 10 in the planned 5 V transistor region not covered by the photoresist. The ions are implanted at a dosage of between about $7.5 \text{ E } 15$ to $3 \text{ E } 16$ atoms/cm² and energy of between about 25 to 45 KeV. The fluoride ions within the semiconductor substrate will increase the oxidation rate of the substrate so that the resulting silicon oxide layer is between about 10 to 20 Angstroms thicker in the implanted region than in the non-implanted region.

Thus, the overall teaching of Hsu is that oxidation can be increased or inhibited by implanting various ions.

Wrister teaches the implantation of oxygen is known to increase the oxidation rate in implanted portions. (Column 2, lines 19-23). Wrister's goal, however, is thicker regions and a concomitant reduction in electric field.

It is well-settled that a prior art reference is relevant for all that it teaches to those of ordinary skill in the art. In re Fritch, 972 F.2d 1260, 1264, 23 USPQ2d 1780, 1782 (Fed. Cir.

1992). Although Wristers is directed to a different goal, it teaches generally that oxygen implantation, through a layer, is known to increase oxidation in a silicon substrate. (column 6, lines 2-7). That is the goal of Hsu's fluorine implantation. Both fluorine and oxygen are recognized as oxidation enhancers in polysilicon in the cited references. As stated in In re Fout, 675 F.2d 297, 301, 213 USPQ 532, 536 (CCPA 1982) "[e]xpress suggestion to substitute one equivalent for another need not be present to render such substitution obvious."

Consequently, we concur with the examiner that claim 1 would have been obvious in view of Hsu and Wristers, and affirm this rejection.

The rejection of Claims 7-8 and 10-12 under 35 U.S.C. §103(a)

The examiner has found that Barsan discloses a processing sequence whereby nitrogen is produced in both high and low concentrations to form three different thicknesses of gate oxide layers. (Examiner's Answer, page 4, lines 19-22). The examiner thus concludes that it would have been obvious to use the oxygen of Wristers in the process of Barsan to form three different layers in Hsu. (Examiner's Answer, page 4, line 22-page 5, line 3).

The appellants urge that Barsan discloses an N-type dopant implant for increased oxide thickness and a nitrogen implant for reduced oxide thickness, but does not teach oxygen. (Appeal Brief, page 7, lines 1-3).

While the appellants are correct in observing Barsan does not teach oxygen, we note that Barsan more generally teaches varying the implant dose of nitrogen towards a greater concentration decreases the oxidation rate. (See, e.g. Figure 5). The ultimate effect taught is that the oxide layer thickness depends upon the nitrogen implanted. (See, e.g. Figure 2). Various steps of nitrogen implantation in different regions to achieve different oxide layer thicknesses are taught. (Column 5, lines 23-57). When combined with the known substitution of oxygen as an oxidizing enhancing implant, motivation and a reasonable expectation of success in forming different oxide thicknesses are present.

Consequently, we concur with the examiner that the subject matter of representative claim 7 would have been obvious to one of ordinary skill in the art at the time the invention was made in view of Hsu, Wristers, and Barsan.

The Rejection of Claims 13-15 Under 35 U.S.C. §103(a)

The examiner has found that Hsu discloses the subject matter of claim 13, with the exception of forming a high dielectric contrast dielectric layer on the substrate, implanting oxygen through the polysilicon layer and into the substrate, and annealing the substrate to form an interfacial oxide layer in the substrate under the dielectric layer. (Examiner's Answer, page 5, lines 8-11). The examiner has additionally found that Mogami

Appeal No. 2001-2590
Application No. 09/449,063

teaches implanting oxygen into the substrate through a silicon nitride (high dielectric constant) layer and into the substrate and annealing to form an interfacial oxide layer. (Id., lines 12-16).

The examiner then concludes that it would have been obvious to form the interfacial oxide layer of Mogami in the primary reference of Hsu to prevent boron from entering the channel of the device which leads to premature transistor failure. (Id., lines 17-20).

The appellants, on the other hand, assert that Mogami teaches doping oxygen into the silicon nitride layer, not through. This, it is urged, creates an oxygen-rich layer along an interface between the silicon nitride and the substrate, not an oxygen-implanted region as claimed. (Appeal Brief, page 7, line 24-page 8, line 1).

We agree with the appellants. Mogami expressly states that the oxygen implantation forms an oxygen-doped silicon nitride film (column 3, lines 15-19, see also column 9, lines 2-5), not that the oxygen is implanted into the substrate as claimed.

The examiner has stated that "inherently a portion of the layer will be formed in the substrate since silicon must be taken from the substrate in order to form the layer." (Examiner's Answer, page 5, lines 15-16). While this may be true in terms of

Appeal No. 2001-2590
Application No. 09/449,063

the oxide layer in the final structure formed, this does not teach implanting oxygen into the substrate in the manner as claimed. Simply adding Mogami to Hsu to reduce boron migration would not necessarily replace the Hsu implantation with Mogami's, it could result in dual implantations. In other words, the motivation to perform the process steps in the manner claimed is lacking.

Accordingly, we reverse this rejection.

Summary of Decision

The rejection of claims 1-6 under 35 U.S.C. §103(a) as being unpatentable over Hsu in view of Wristers is sustained.

The rejection of claims 7-8 and 10-12 under 35 U.S.C. §103(a) as being unpatentable over Hsu in view of Wristers as applied to claims 1-6, and further in view of Barsan is sustained.

The rejection of claims 13-15 under 35 U.S.C. §103(a) as being unpatentable over Hsu in view of Mogami is reversed.

Appeal No. 2001-2590
Application No. 09/449,063

No time period for taking any subsequent action in connection
with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED-IN PART

CHARLES F. WARREN)	
Administrative Patent Judge)	
)	
)	
)	BOARD OF PATENT
PETER F. KRATZ)	
Administrative Patent Judge)	APPEALS AND
)	
)	INTERFERENCES
)	
JAMES T. MOORE)	
Administrative Patent Judge)	

JTM/kis

Appeal No. 2001-2590
Application No. 09/449,063

BEYER, WEAVER & THOMAS LLP
P. O. BOX 778
BERKELEY, CA 94704-0778